animal heat; and arrives at the following results. He finds that the blood is capable of absorbing oxygen both from atmospheric air, and from oxygen gas, independently of putrefaction. After blood has been agitated in common air, a trace of carbonic acid, not exceeding one per cent., is found in the residual air; but when pure oxygen is employed, no carbonic acid can be detected in it by the most carefully conducted trials. When pure carbonic acid is brought into contact with blood, or serum, over mercury, and moderately agitated, the absorption of gas exceeds the volume of the fluid. Both arterial and venous blood are rendered very dark, and serum more liquid by the absorption of this gas to saturation. Serum, in its healthy state, is incapable of absorbing oxygen, or of immediately furnishing carbon to form carbonic acid: and after it has absorbed carbonic acid, only one-tenth of the absorbed gas is expelled by successive agitation with atmospheric air, or with hydrogen. The author is inclined to think that the alkali in the blood, in its healthiest condition, is in the state of a sesquicarbonate. In the majority of trials manifest indications of the disengagement of air from blood *in vacuo* were obtained: but as it occasionally happened that no air could be thus extricated, the author is induced to believe that the quantity of air contained in the blood is variable: and he has found this air to consist solely of carbonic acid gas. It would also appear, from the experiments detailed in this paper, that a portion of oxygen exists in the blood, not capable of being extracted by the air-pump, yet capable of entering into combination with nitrous gas; and existing in largest proportion in arterial blood. The absorption of oxygen by blood is attended with an increase of temperature.

The experiments of the author tend to show that the lungs are absorbing and secreting, and perhaps also inhaling organs, and that their peculiar function is to introduce oxygen into the blood and separate carbonic acid from the blood: and they favour the idea that animal heat is owing, first, to the fixation or condensation of oxygen in the blood in the lungs during its conversion from venous to arterial; and secondly, to the combinations into which it enters in the circulation in connexion with the different secretions and changes essential to animal life.

"On the Geometrical Forms of Turbinated and Discoid Shells." By the Rev. H. Moseley, Professor of Natural Philosophy and Astronomy in King's College, London. Communicated by Thomas Bell, Esq., F.R.S.

This paper is occupied by an investigation of certain mathematical principles which the author considers as governing the formation of turbinated and discoid shells. According to these views, all such shells may be conceived to be generated by the revolution about a fixed axis of the perimeter of a geometrical figure, which, remaining always similar to itself, increases continually its dimensions. The spiral lines which are observable on the opercula of certain classes of shells, taken in connexion with the well-known properties of the

logarithmic or equiangular spiral, appear to have suggested the idea, that not only the boundary of the operculum, which measures the sectional expansion of a shell, but also the spiral lines, which in general are well marked both externally and internally in the shell itself, are curves of this nature.

From an examination of the spirals marked on opercula, it appears that the increase of their substance takes place on one margin only; the other margin still retaining the spiral form, and acquiring an increase of length by successive additions in the direction of the curve. As in the logarithmic spiral the distances of successive spires, measured on the same radius vector produced from the pole, from each other, are respectively in geometrical progression, if similar distances between the successive whorls on the opercula of shells be found to observe the same law, it will follow that these whorls must have a similar form; and that such is the case, the author shows by a variety of numerical results obtained by careful measurements on three different opercula of shells of the order *Turbo*. That such is the law of nature in the formation of this class of shells is rendered probable by the instances adduced by the author, in which a conformity to this law is found to exist.

From the known properties of the logarithmic spiral the author concludes that the law of the geometrical description of turbinated shells is, that they are generated by the revolution about a fixed axis, (namely, the axis of the shell,) of a curve, which continually varies its dimensions according to the law, that each linear increment shall vary as the existing dimensions of the line of which it is the increment. If such be the law of nature, the whorls of the shell, as well as the spires on the operculum, must have the form of the logarithmic spiral; and that this is likewise the case is shown by the almost perfect accordance of numerical results, deduced from the property of that curve, with those deduced from a great variety of careful measurements made of the distances between successive whorls on radii vectores drawn on shells of the *Turbo duplicatus*, *Turbo phasianus*, *Buccinum subulatum*, and in a fine section of a *Nautilus pompilius*. The author further states that, besides the results given in the paper, a great number of measurements were similarly made upon other shells of the genera *Trochus*, *Strombus*, and *Murex*, all confirmatory of the law in question.

One of the interesting deductions which the author has derived from the prevalence of this law in the generation of the shells of a large class of mollusca, is that a distinction may be expected to arise with regard to the growth of land and of aquatic shells, the latter serving both as a habitation and as a float to the animal which forms it; and that, although the facility of varying its position at every period of its growth may remain the same, it is necessary that the enlargement of the capacity of the float should bear a constant ratio to the corresponding increment of its body; a ratio which always assigns a greater amount to the increment of the capacity of the shell than to the corresponding increment of the bulk of the animal.

Another conclusion deducible from the law of formation here con-

sidered is, that the growth of the animal, corresponding to a given increment in the angle of the generating curve, will always be proportional to the bulk it has then attained: and if the physical vital energies of the animal be proportional to its actual bulk, its growth, in any given time, will be proportional to its growth up to that time. Hence the whole angle of revolution of the curve generating the shell will be proportional to the whole corresponding time of the animal's growth; and therefore, the whole number of whorls and parts of whorls will, at any period, be proportional to its age.

The form of the molluscous animal remaining always similar to itself, the surface of the organ by which it deposits its shell will vary as the square of the linear dimensions; but as the deposition of its shell must vary as the cube of the same dimensions, there must be an increased functional activity of the organ, varying as the simple linear dimensions.

Since to each species of shell there must correspond a particular number expressing the ratio of the geometrical progression of the similar successive linear dimensions of the whorls; and since the constant angle of the particular logarithmic spiral, which is affected by that species of shell, is deducible from this number, the author considers that, connected as the form of the shell is with the circumstances of the animal's growth and the manner of its existence, this number, or the angle of the particular spiral, determinable as it is in each case by actual measurement, may be available for the purposes of classification, and may suggest relations by which, eventually, they may become linked with characteristic forms, and modes of molluscous existence.

The concluding portion of the paper contains a mathematical discussion of certain geometrical and mechanical elements of a conchoidal surface. These are, the extent of the surface itself; the volume contained by it; the centre of gravity of the surface, and also of the volume, in each case, when the generating figure revolves about a fixed axis without any other motion, and also when it has, besides this, a motion of translation in the direction of that axis; and, lastly, the angle of the spiral. The author states that his object in this inquiry is the application of these elements to a discussion of the hydraulic theory of shells. The constant angle of the spiral, which each particular species affects, being connected by a necessary relation with the economy of the material of the habitation of each, with its stability, and the condition of its buoyancy, it is therefore necessary to determine the value of this angle.

"On the relative attractions of Sulphuric Acid for water, under particular circumstances: with suggestions of means of improving the ordinary process of manufacturing Sulphuric Acid." By Henry Hugh Watson, Esq., Corresponding Member of the Manchester Philosophical Society. Communicated by John Dalton, D.C.L., F.R.S., &c.

The object of the inquiry detailed in the present paper is to determine at what degree of concentration the affinity of sulphuric